

**CONFIDENTIAL***Handwritten signature*APQ-56 SERVICE NOTES

#7

25 OCTOBER 1957AN/APQ-56 TIME-SHARED SYSTEMS

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RECORDER ADJUSTMENT PROCEDURES FOR LOW ALTITUDE (0-1500 feet) OPERATIONINTRODUCTION

It has been determined that some of the Recorder Adjustment Procedures outlined in Field Service Procedures Test Specification T-611953 must be revised for systems using antennas designed for 1000 foot, 15 mile sweep, operation. The paragraphs affected are B-3-d, B-3-e, B-3-f and C-3-j.

Improved low altitude mapping can be obtained by increasing the dynamic range of the receiving system and thereby accommodating the strong signal return inherent in low altitude mapping. The increased dynamic range is basically obtained by adjusting the system to operate on minimum video gain.

The receiving system transfer characteristics are the net result of the combined characteristics of the Video Amplifier, Post Amplifier, and the AGC circuitry. To better understand the following explanation, an idealized set of receiving system transfer characteristics are shown in Figure 1.

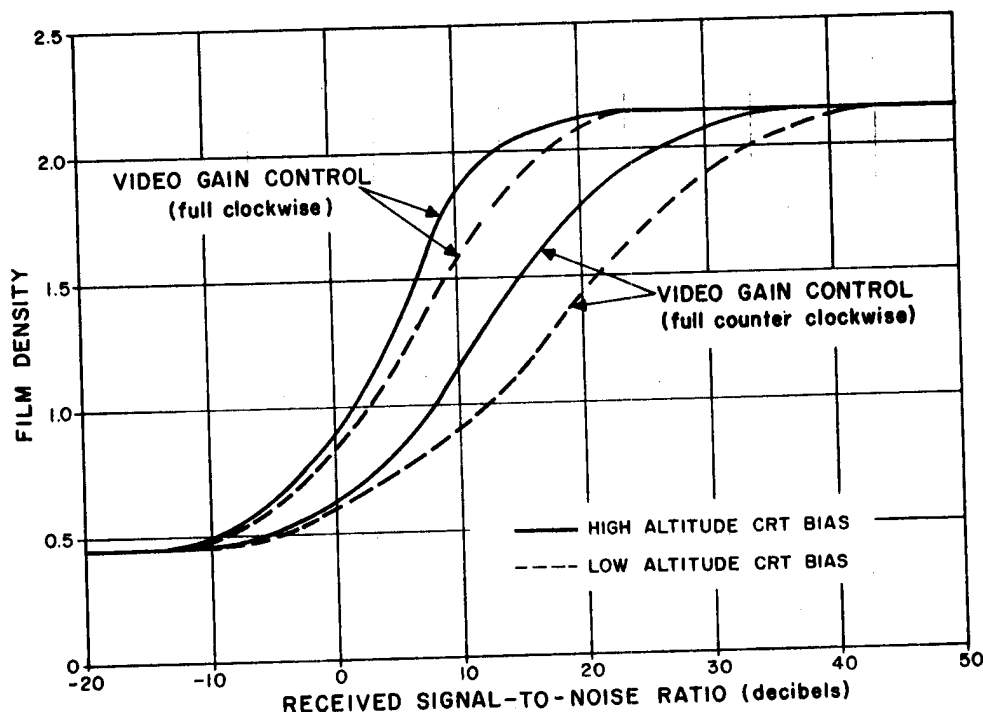


Figure 1: Receiving System Transfer Characteristics

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For example, with the CRT bias adjusted for high altitude, it can be seen that for any particular signal-to-noise ratio, the system gain decreases as the video gain control is turned from the maximum (full CW) to the minimum (full CCW) position. The net decrease in gain occurs because of the fact that as the video gain is decreased, the AGC circuit tends to hold the noise level constant by increasing the gain of the post amplifier. This increase in gain, however, places the signal level at a more non-linear or compressed portion of the post amplifier characteristic (output vs. input) resulting in an overall decrease in system gain.

This decrease in system gain allows larger signals to be received and amplified without exceeding the preset limit level and thereby an increase in dynamic range is affected.

Further increase in dynamic range is possible by adjusting the recorder controls according to the revised low altitude adjustment procedures. When the CRT bias is reduced according to the procedure described in the revised paragraph B-3-d, the AGC produces a more negative output thereby reducing the post amplifier gain to compensate for the increased CRT light level.

This reduced gain, which in this case is clearly a reduced overall gain, allows larger received signals before the limit level is exceeded thereby further increasing the dynamic range of the system.

LOW ALTITUDE RECORDER ADJUSTMENT PROCEDURES

(Paragraph numbers refer to paragraphs of Field Service Procedures T Spec. T-611953).

## B-3-d Low Altitude CRT Bias Adjustments.

5, 10, or 15 mile sweep, 0 - 5000 ft. altitude.

Make the adjustments as per the high altitude procedure described in paragraph B-3-d but do not remove the test leads connecting (-)300 V and BIAS TEST jacks on the recorder to the recorder test set.

Measure the voltage at  $P_4$  of recorder test set with TEST SELECTOR switch  $S_1$  in position B ( $E_{C2}$ ) and also in position C ( $E_{C3}$ ). Solve for the new voltage value of  $E_{C3}$  from the relationship  $E_{C3} = E_{C3} - 1/2 (E_{C3} - E_{C2})$ .

With TEST SELECTOR switch  $S_1$  in the C position, turn BIAS ADJ on the recorder to secure the new value of  $E_{C3}$  at  $P_4$  of recorder test set.

Remove the test leads connecting (-)300 V and BIAS TEST jacks on the recorder to the recorder test set.

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- B-3-e** Low Altitude Video Limit Level Adjustments.
- a. 15 mile sweep - Turn the TEST SELECTOR switch on the recorder test set to the LIMIT position. Turn the VIDEO GAIN switch to the MAX position. Check that the CRT INTENSITY meter indicates  $0.60 \pm 0.02$  ma. If necessary adjust the LIMIT LEVEL control on the recorder. Whenever an adjustment is made to the LIMIT LEVEL control the GAIN SHIFT and GAIN RANGE controls on the recorder must be adjusted as described in the low altitude portions of B-3-f described below.
  - b. 10 Mile Sweep.  
Follow procedure under paragraph a. above except that CRT intensity meter should read  $0.40 \pm 0.02$  ma.
  - c. 5 Mile Sweep.  
Follow procedure under paragraph a. above except that CRT intensity meter should read  $0.25 \pm 0.02$  ma.
- B-3-f** Low Altitude Video Gain Adjustments.
- a. 15 Mile Sweep.  
Turn the TEST SELECTOR switch on the recorder test set to LOW LEV. and the TEST SIGNAL AMPLITUDE switch to position 7. Turn the AGC GAIN switch to LOW and the VIDEO GAIN switch to MAX. Adjust the GAIN SHIFT control on the recorder until the CRT INTENSITY meter indicates  $0.25 \pm .02$  ma. Turn the VIDEO GAIN switch to MIN. and the TEST SELECTOR switch to HIGH LEV. Place TEST SIGNAL AMPLITUDE switch in position 3, and AGC GAIN switch in LOW position. Adjust the GAIN RANGE control on the recorder until the CRT INTENSITY meter indicates  $.25 \pm .02$  ma. Repeat all of the above steps until both meter readings are obtained without further adjustment.
  - b. 10 Mile Sweep.  
Use procedure in paragraph a. above except that GAIN SHIFT control is to be adjusted until CRT INTENSITY meter indicates  $.22 \pm .02$  ma. and GAIN RANGE control is to be adjusted until CRT INTENSITY meter indicates  $.22 \pm .02$  ma.

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## c. 5 Mile Sweep.

Use procedure in paragraph a. above except that GAIN SHIFT control is to be adjusted until CRT INTENSITY meter indicates  $.19 \pm .02$  ma., and GAIN RANGE control is to be adjusted until CRT INTENSITY meter indicates  $.19 \pm .02$  ma.

C-3-j Set GAIN control to minimum (full counterclockwise position) for all low altitude (0 to 2000 foot) flights.

NOTE

After the above adjustments have been made, particularly for 500-foot altitude, 5-mile sweep operation, it is possible to receive saturation signals throughout the sweep range as determined by observation of the A-Scope Monitor, or by observing that the film results are generally too dark throughout. This is more likely to occur over built-up areas. A technique that has been successfully used to assist in producing good film results is to adjust the antenna tilt of the roll stabilized antennas to a position higher than optimum, thus directing some of the power of the antenna beam to a point on the ground beyond the sweep range and reducing the intensity of the return signals. The optimum adjustment for a given set of operating conditions (including magnetron power) can really be determined only by experience of the operator in comparing the observed DA-scope returns during a given flight to the film results obtained for that flight.

USE OF NAVIGATION INDICATOR WITH AN/APQ-56 TIME-SHARED SYSTEMS

In the time-shared APQ-56, the ground distance travelled in the direction of heading and the ground distance "drifted" perpendicular to the direction of heading are required inputs to the radar mapping device in order to produce distortionless maps. A simple navigational tool, the Navigation Indicator, has been developed to take advantage of the integration features provided in the APQ-56 recorder to measure these quantities. The Navigation Indicator, because it was adapted to an already designed component, is not a precision device, but is merely two counters that, within certain limits, records for the pilot's convenience, ground distances "along" (in the direction of) heading, and the ground distance "across" (perpendicular to the direction of) heading in nautical miles. A RESET button is provided on the indicator to return both counters to zero. It should be noted that the present Navigation Indicator is designed to operate properly with 15-mile sweeps only.

Proper use of the Navigation Indicator requires an understanding of its limitations since errors of +7 miles to -23 miles in the "along" direction are possible, depending upon the instant the RESET button is depressed. Since the ALONG HEADING distance counter on the Navigation Indicator is operated by the pulse that actuates the range marks in the recorder, which pulse is generated every 15 miles (with 15-mile sweeps), it merely counts 15-mile intervals. The first "along" pulse received after "reset" is recorded on the counter as 7 miles. Each succeeding pulse adds 15 miles up to a total of 999. If reset is accomplished the instant before an actuating pulse is received an indication of 7 miles shows when the actual distance traveled is zero.

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At 15 miles travelled the second pulse sets 22 miles into the counter. Then if the counter is read an instant short of 30 miles travelled (22 still on the counter) an error of -8 miles exists. However, if reset is accomplished the instant after an actuating pulse is received an indication of 0 shows when the actual distance travelled is zero. At 15 miles travelled the counter will indicate 7 miles. Then if the counter is read the instant before the actuating pulse for 30 miles travelled, the indication remains 7 for 30 miles travelled for a maximum error of -23 miles. In any case, immediately after advance of the ALONG HEADING counter the maximum error is approximately  $\pm 7$  miles. These limitations become of much less consequence at longer ranges.

The ACROSS HEADING distance counter is operated by the pulse that "dumps" and resets the recorder drift. This pulse is generated each time the drift reaches its outer limit (2-1/2 miles in either direction from zero). Reaching the outer limit resets drift 4 miles in the opposite direction. Each pulse adds 4 miles to the LEFT or RIGHT drift indication on the counter. Depressing the RESET button on the Navigation Indicator resets both LEFT and RIGHT counters to zero. Therefore, after reset, a drift right of 2-1/2 miles sets "4 miles right" on the across distance RIGHT counter. An instant prior to "dump" the error is 2-1/2 miles left since both counters still read zero. This is the maximum counter error, that is within  $\pm 2\frac{1}{2}$  miles depending upon whether drift is left or right. The total across distance (LEFT or RIGHT) that may be accumulated is 99 nautical miles.

The APQ-56 accuracy is  $\pm 2\%$  of the total ALONG HEADING distance reading or  $\pm 3\%$  of the total ACROSS HEADING distance reading. To this must be added the inaccuracy of the navigation input data to the APQ-56, which may be automatic or manual, to obtain the overall system inaccuracies.

Two types of installations exist in conjunction with the General Precision Laboratory type PC-210 Radan Doppler Navigation Radar. One uses a heading selector; the other does not. Since most of the heading selectors are being eliminated, operation of the system without a radar heading selector will be first described.

It is contemplated that the pilot will plan his flight taking into consideration whether his heading indication is magnetic or true and work out a series of check points with heading and distance between each point. With the APQ-56 and Radan equipment in operation, the pilot should depress the RESET button as he crosses the I.P. (Initial Point), and take up the required heading to the first check point. He should hold a constant heading until the ALONG HEADING counter indicates the measured distance between the I. P. and the first check point; the ACROSS HEADING distance counter indicates how far he has drifted off course and, within the limits of the accuracies of the equipments as described above, his present location. More likely, his technique will be to start on his planned heading, read drift from the Radan indicator and modify his heading to compensate for drift. In this event, the proper ALONG HEADING counter indication places him (within the equipment limits of accuracy) over the check point and the ACROSS HEADING indication is a record of the distance drifted. By selecting easily identified check points, the pilot could compensate by visual observation for accumulated errors in the final phase of his leg and cross over the first check point, depressing the RESET button at that instant and taking up the heading of the next leg. If visual compensation is not possible at the check points, accumulated errors go into the navigational inaccuracy of using the system.

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Where a Radan heading selector is installed, operation is the same except that the selector must be set to the heading flown by the aircraft and the ACROSS HEADING distance counter accumulates a distance proportional to drift plus errors in maintaining the selected heading. Large heading errors will obviously result in a distorted APQ-56 map.



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Phasing procedures I and III outlined below may be performed independently of one another.

I. Phasing of the 7.5K pot (R4606)

1. Remove the cover and printed circuit mounting plate.
2. Remove the camera from the recorder to gain access to the NDF (Neutral Density Filter).
3. Remove the four mounting screws holding the motor-pot. - NDF subassembly to the camera. Position the subassembly so that the NDF may be easily removed.
4. Looking at the NDF side of subassembly, rotate the NDF CCW until the motor gear pin hits the stop. Mark the meshing teeth of the motor gear and the NDF gear to enable exact remeshing in Step 6. Remove the retaining ring on the lower end of the NDF shaft and unmesh the NDF gear.
5. Position the gear of the 7.5K pot so that a minimum resistance (approximately 25 ohms or less) is obtained between terminals B and C.
6. Remesh the NDF gear so that it is positioned as in Step 4, and check that there is still 25 ohms or less resistance between terminals B and C.
7. Replace the NDF retaining ring and remount the sub-assembly on the camera.
8. Install the camera on the recorder and replace the plate and cover.
9. Perform the phasing check outlined in II.

II. Phasing Check of the 7.5K pot.

Place the radar set in the standby position. Check that as the Ground Speed is varied over the range of 200 to 1000 knots, the DC voltage between J-4624 and ground varies in accordance with the table shown below. A VTVM must be used for this measurement.

<u>GROUND SPEED</u>	<u>VOLTAGE AT J-4624</u>
(Knots)	(Volts)
1000	7.1 $\pm$ 10%
800	5.7 $\pm$ 10%
600	4.25 $\pm$ 10%
400	2.85 $\pm$ 10%
200	1.42 $\pm$ 15%

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### III. Phasing of the Neutral Density Filter (NDF)

1. Remove the focus and alignment fixture or magazine from the camera.
2. Remove cover and printed circuit mounting plate.
3. Remove the camera from the recorder.
4. Rotate the NDF maximum CCW.
5. The dividing line should be located as shown in Figure 1 when looking down through the slot at the top of the camera.
6. If the dividing line is not located as shown in Figure 1:
  - a. Remove the motor-pot-NDF sub-assembly as outlined in Step 3 of Paragraph I.
  - b. Loosen the three screws on the circular metal plate under the NDF.
  - c. Rotate the NDF with respect to the NDF gear so as to obtain the desired position of the dividing line as shown in Figure 1.
  - d. Tighten the three screws, remount the sub-assembly, and check that the dividing line is positioned as in Figure 1.
  - e. Repeat a, b, c and d, if necessary, to obtain the desired results.
  - f. Replace the printed circuit mounting plate and cover.
7. Perform phasing check outlined in IV.

### IV. Phasing Check of Neutral Density Filter (NDF)

1. Install the magazine, loaded with several feet of film, on the recorder.
2. Remove P5508.
3. Set the ALTITUDE control on the Control Panel to 0.
4. Connect J1 on the recorder test set to J5503 on the Recorder. Connect -300V (J2) on the test set to -300V (J5517) on the Recorder. Connect Bias (J4) on the test set to Bias Test (J5519) on the Recorder. Turn the Test Selector switch, S1, on the Test Set to the B position. Turn the power on, and adjust the Bias Adjust B control on the Test Set for a 0.5 ma reading.
5. Allow the Recorder to run for 30 seconds at ground speeds of 200, 400, 600, 800 and 1000.

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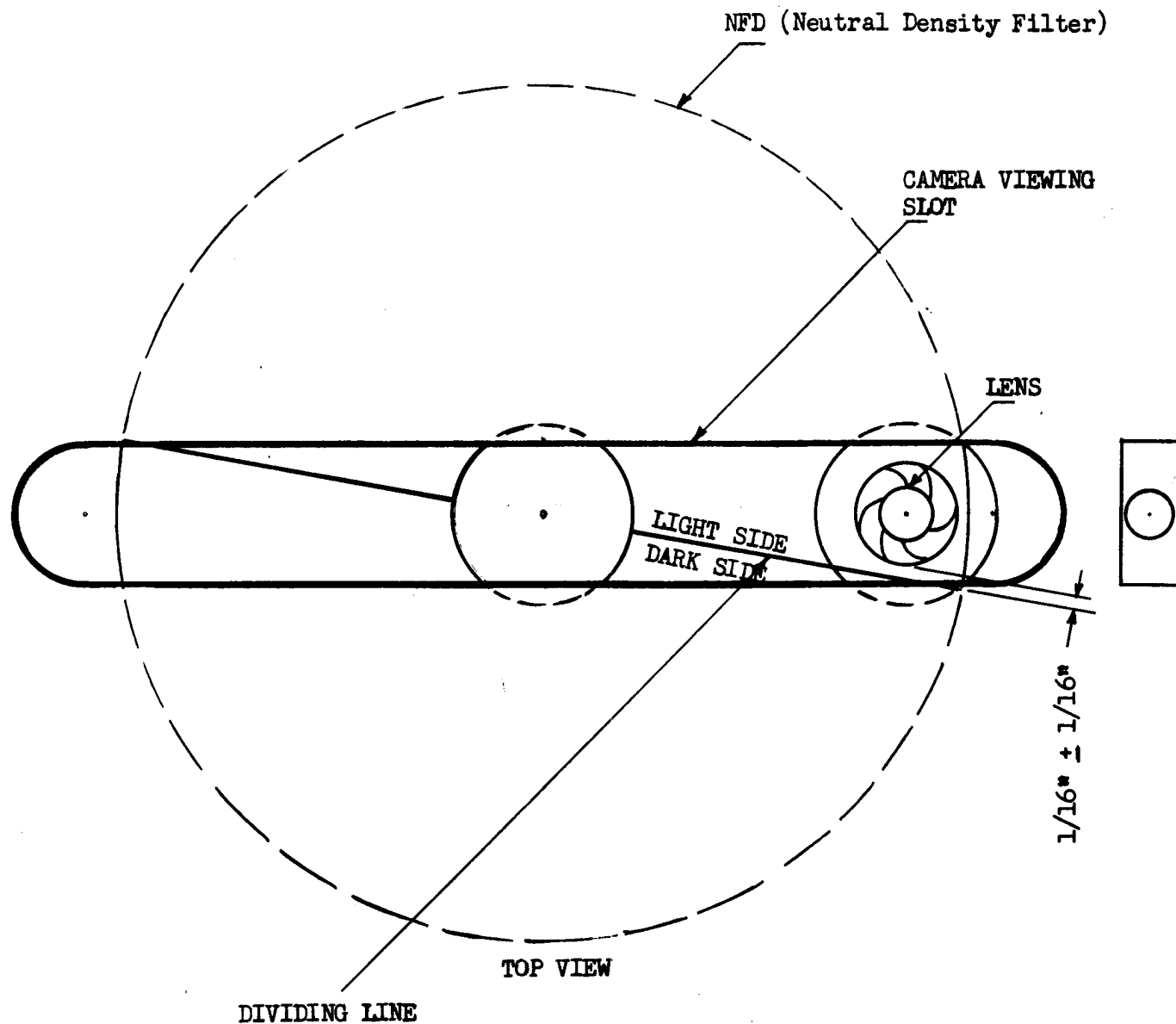


FIGURE 1: NEUTRAL DENSITY FILTER PHASING

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IV. Phasing Check of Neutral Density Filter (NDF) - (Continued)

6. Process the film per Paragraph 4.26 of T-554312 and check that the density variation in the lengthwise direction is less than 0.1. The density of the exposed film should be  $0.60 \pm 0.20$ .

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